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$$2d(xy)=2(x+y)(dx+dy)-2xdx-2ydy.$$

i. e. $d(xy)=xdx+xdy+ydx+ydy-xdx-ydy.$

i. e. $d(xy)=xdy+ydx.$

From this may be derived rules for $d(xyz)$, etc., and $d(x/y)$.

8. Here would follow demonstration by differentials of Binomial Formula for all values of n, with exercises.

9. Here would follow the algebraic deduction of some such formula as :

$$\log(1+z)=M(z-\tfrac{1}{2}z^2+\tfrac{1}{3}z^3-\ldots\ldots \text{ ad inf.})$$

$$\text{whence } d(\log 1+z)=M(1--z+z^2-\ldots\ldots\text{ad inf.})dx$$

$$d(\log 1+z)=M.\frac{1}{1+z}.dx$$

or, putting x for $1+z$ we have

$$d\log x=M(dx/x).$$

Whence may be derived $d(a^x)=a^x\log a$, etc.

10. Here would follow the algebraic deduction of

$$\sin x=x-(x^3/3\,!)+(x^5/5\,!)-(x^7/7\,!)+\ \ldots\ldots \tag{1}$$

$$\text{and } \cos x=1-(x^2/2\,!)+(x^4/4\,!)-(x^6/6\,!)+\ldots\ldots \tag{2}.$$

From (1), $d(\sin x)=\{1-(x^2/2\,!)+(x^4/4\,!)-(x^6/6\,!)+\ldots\ldots\}dx=\cos xdx$,

and from (2), $d(\cos x)=-\sin xdx$, etc.

11. Then might follow applications to questions of maxima and minima, etc. Then deduction of Taylor's Theorem, with applications.

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ARITHMETIC.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

79. Proposed by F. M. PRIEST, St. Louis, Mo.

How many \$20 gold pieces can be put in a room 20 feet long, 18 feet wide, 9 feet high?

Solution by B. F. FINKEL, A. M., M. Sc., Professor of Mathematics and Physics, Drury College, Spring-Springfield, Missouri.

A $20 gold piece is about $\frac{8}{100}$ of an inch thick, and about $1\frac{7}{20}$ inches in diameter. By putting the pieces in cylindrical layers lengthwise of the room, we can place $(18\times12)\div1\frac{7}{20}$ or 160 cylinders in the first layer, each cylinder containing $(20\times12)\div\frac{8}{100}$ or 3000 $20 gold pieces. By rectangular arrangement of the cylinders we can put in $(9\times12)\div1\frac{7}{20}$ or 80 layers. Hence, by this arrangement, we can put $80\times160\times3000=38,400,000$ pieces in the room.

By laying the cylinders of the second layer of cylinders between two cylinders of the first layer, the distance between the plane of centers of the first layer and the plane of centers of the second layer is $\sqrt{(\frac{27}{20})^2-(\frac{27}{40})^2}=\frac{27}{40}\sqrt{3}$. Hence, there can be placed in the room, by this arrangement, $(9\times12)\div\frac{27}{40}\sqrt{3}$ or 92 layers+.376 of a layer.

In these 92 layers 46 layers would contain 160 cylinders and 46 would cantain 159. But since there is still room at the top the last layer can be placed in so as to contain 160 cylinders.

Hence, there will be 47 layers of 160 cylinders and 45 layers of 159.

Since each cylinder contains 3000 $20 gold pieces, there can be placed in the room by this method $(47\times160+45\times159)\times3000=44,025,000$ pieces.

It is possible that by considering other dimensions in the same way as the width in this solution a still larger number may be placed in the room.

Charles C. Cross obtained as his answer 38,400,000.

80. Proposed by CHARLES C. CROSS, Laytonsville, Maryland.

From a cask containing 10 gallons of wine, a servant drew off 1 gallon each day, for five days, each time supplying the deficiency by adding a gallon of water. Afterwards, fearing detection, he again drew off a gallon a day for five days, adding each time a gallon of wine. How many gallons of water still remained in the cask? [From *Quackenbos' Arithmetic.*]

Solution by B. F. FINKEL, A. M., M. Sc., Professor of Mathematics and Physics, Drury College, Springfield, Missouri.

Let 10 gallons$=a$, 1 gallon$=b$, the quantity of water or wine added after each draught, $\frac{1}{10}=b/a=1/n$, the part drawn off each time.

Then $a-a/n=a\left(\frac{n-1}{n}\right)$=quantity of wine left after first draught;

$a\left(\frac{n-1}{n}\right)-1/n$ of $a\left(\frac{n-1}{n}\right)=a\left(\frac{n-1}{n}\right)^2$=quantity of wine left after second draught;

$a\left(\frac{n-1}{n}\right)^2-1/n$ of $a\left(\frac{n-1}{n}\right)^2=a\left(\frac{n-1}{n}\right)^3$=quantity of wine left after third draught; and $a\left(\frac{n-1}{n}\right)^m$=quantity left after the mth draught$=A$.